REPORT OF THE

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FORAGE LEGUME WORKSHOP

St. Paul, Minnesota
February 12-13, 1991

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Schedule of ARS Forage Legume Workshop -2/12-13/91

St. Paul, MN

Tuesday, February 12, 1991

8:00 - 10:00 AM - Introductions and discussion of purpose of workshop.

Overview of present forage legume research effort

Assign 5 discipline discussion workgroups

1) Breeding
2) Physiology
3) Pathology
4) Entomology
5) Utilization and Management

10:00 - 12:00 - In discipline workgroups, identify research needs.

12:00 - 1:00 Lunch

1:00 - 2:00 - Workgroup reports

2:00 - 4:00 - Form new workgroups across disciplines and with list of research needs identified above determine:

What research should ARS do?
(Note: Your workgroup can add research needs to list)

What is its priority?

What expertise does ARS presently have to do the research?

What additional expertise is needed?

Where should the research be conducted?

4:00 - 5:00 Report from workgroups

6:00 - ? Evening activity to be planned

Wednesday, February 13, 1991

8:00 - 11:00 AM Discuss workgroup reports from previous day - reach consensus on priority needs, present expertise, etc.

11:00 - 12:00 Evaluation of the review process and discussion on appropriate interactions with constituents

12 Noon Adjourn workshop

Note:

1:00 - 5:00 PM Group recorders are asked to stay for the afternoon to draft workshop report (Plan of ARS Forage Legume Research for the 1990's)

Discipline Groups for the Forage Legume Workshop

St. Paul, MN 2/12-13/91

Groups in AM

Breeding	Physiology	Pathology	Entomology	Utiliz. & Manage.
Townsend(L)	Vance(L)	Russelle	Elden(R)	Jung(L)
Skinner	Bauchan	O'Neill(L)	Ellsbury	Burns(R)
Campbell	Hatfield	McLaughlin	Kamm(L)	Steiner
Pederson	Gustine	Larsen	Byers	Tharel
Rumbaugh	Frank	Thies (R)	Barnes	Williams
Peaden	Buxton(R)	Elgin		Mowrey
Smith(R)	Rowe			Baligar
Beuselinck				
Berdahl				

Groups in PM

1	2	3	4
Pederson	Skinner	Townsend	Beuselinck(L)
Vance	Buxton(R)	Gustine	Berdahl
Elden	Kamm	Larsen	Bauchan
McLaughlin	Mowrey	Steiner(L)	Rowe
Tharel	Campbell	Jung	Byers
Rumbaugh	Russelle(L)	Smith(R)	Burns(R)
Hatfield(L)	Peaden	Frank	Barnes
Thies (R)	Elgin	Ellsbury	Williams
Baligar		O'Neill	

Forage Legume Workshop Report - February 1991

A) Purpose of Workshop

The purpose of the forage legume workshop was to identify future forage legume research needs that would constitute a plan for direction of ARS-USDA forage legume research for the coming decade and beyond. This plan, therefore, would delineate ARS program goals, thus charting a course for program direction and supporting funding requests. Without such a plan there will be a growing sense of research fragmentation and non-direction. Although attendance at the workshop was not mandatory, all invitees were in attendance. Don Barnes (St. Paul, MN) served as host. The workshop was held in Borlaug Hall on the St. Paul campus of the University of Minnesota.

It was the intent of the workshop to have developed at its ending a document that included:

1) Status of ARS research at present, and
2) Prioritized research needs for forage legumes.

The following sections constitute that report.

B) Current ARS Forage Legume Research

I. Breeding and Genetics

Crop	Location	SY	Activity
Alfalfa	Beltsville, MD	Bauchan Campbell	Cytogenetics, interspecific hybridization, germplasm development molecular biol, pest resistance
	Manhattan, KS	Vacant	Germplasm development, molecular biology
	St. Paul, MN	Barnes	Germplasm development, nitrogen fixation pest resistance, quality, stress
resistance			
	Prosser, WA	Peaden	Germplasm development, pest resistance
	Logan, UT	Rumbaugh	Germplasm development, stress resistance
	Mandan, ND	Berdahl	Germplasm development, stress resistance
	Ft. Collins, CO	Townsend	Germplasm development, stress resistance
Red Clover	Madison, WI	Smith	Germplasm development, quality, stress resistance
	Corvallis, OR	Kamm	Seed production, entomology
White Clover	Miss. State, MS	Pedersen	Germplasm development, stress resistance
Other Clover	Miss. State, MS	Pedersen Rowe	Annual clovers, germplasm development, adaptability

	Corvallis, OR	Barker Steiner	Misc. clovers, seed production
	Logan, UT	Rumbaugh	Sweet clover, use in attempted crosses for tannin transfer to alfalfa
	Madison, WI	Smith	Kura clover, germplasm development, adaptability
Birdsfoot Trefoil	Columbia, MO	Beuselinck	Germplasm development, cytogenetics, quality, stress resistance, seed production
	Corvallis, OR	Barker Steiner	Seed production
	Madison, WI	Smith	Germplasm development
Cicer Milkvetch	Fort Collins, CO	Townsend	Germplasm development, stress resistance seed production

II Physiology and Pathology

Crop	Location	SY	Activity
A. Physiology			
Alfalfa	St. Paul, MN	Vance	Nitrogen and Carbon assimilation, enzyme activity, nutrient exchange
	Logan, UT	Johnson	Rhizobium/legume interactions, competition, drought effects
	Mandan, ND	Frank	Drought tolerance, salinity
	University Park, PA	Gustine	Charactize disease resistance, induction of phytoalexins, hypersensitive response
	Madison, WI	Hatfield	Cell wall structural polysaccharides and interaction with lignins and phenolics, cell wall modification, biosynthesis of phenolic compounds
process,	Ames, IA	Buxton	Water stress, lignification cell wall carbohydrate digestion, plant adaptation and ecology
	Beckley, WV	Belesky, et al	Al-stress physiology, nutrient use efficiency, plant adaptation and ecology
B. Pathology			
Alfalfa	Beltsville, MD	O'Neil	Biochemical basis for defense mechanism and induced resistance

	University Park, PA	Leath Gustine	Biocontrol and biochemical basis for resistance mechanisms; root pathogen - insect interactions
	St. Paul, MN	Thies Samac	Root lesion nematode, bacterial wilt and Fusarium wilt resistance with use of molecular markers
	Logan, UT	Griffin	Crop losses due to nematodes
	Prosser, WA	Larsen	Virus effects and resistance screening
Clovers resistance	Madison, WI	Smith	Evaluate red clover for Sclerotinia, anthracnose, nematode, and mildew
	Miss. State, MS	Pratt	Evaluate white, crimson, and subterranean clover and Sclerotinia resistance
		McLaughlin	Virus resistance
		Windham	Root-rot nematode resistance

III. Entomology

Crop	Location	SY	Activity
Alfalfa	Ithaca, NY	Corruthers	Biocontrol of grasshoppers, aphids, and potato leafhopper
	Tucson, AZ	Jones Jackson	Biocontrol of lygus
	Newark, DE	Day	Biocontrol of alfalfa weevil, potato leafhopper and clover aphid
	Behoust, FR	Hopper	Biocontrol of plant bugs
	Beltsville, MD	Elden	Resistance to alfalfa weevil and potato leafhopper
	Univ. Park, PA	Byers	Resistance and biocontrol of clover root curculio
Red Clover	Corvallis, OR	Kamm	Seed chalcids, behavior processes, attractants
White Clover	Miss. State, MS	Ellsbury	Screening for resistance to clover head weevil, clover root curculio, aphid virus transmission

IV. Forage Legume Utilization and Management

Crop	Location	SY	Activity
Alfalfa	Madison, WI	Mertens Satter	Use of alfalfa for dairy nutrition, high forage quality, and production systems
	E. Lansing, MT	Rotz	Modeling of alfalfa utilization in dairy system (DAFOSYM)
Other legumes	Univ. Park, PA	Jung	Use of white clover in pastures
	Beckley, WV	Belesky et al.	Use of clovers, flat pea and trefoil in pasture
	Brooksville, FL	Williams Hammond	Use of perennial peanut in pasture
	Booneville, AR	Tharel	Develop efficient legume pasture systems
	El Reno, OK	Mowrey	Use of annual legumes in pasture
	Miss. State, MD	Brink	Use of white clover and subterranean clover in pasture
	Corvallis, OR	Steiner	Evaluation of seed production of trefoil and other legumes (except alfalfa)
	Raleigh, NC	Burns Fisher	Use of legumes in perennial grass pastures

C) Future Forage Legume Research Needs

The following listing of research needs was determined by consensus of the participants of the workshop. They are listed in four priority groupings. The order within the four priority groupings is not prioritized.

Priority I. -- Increase Persistence in Forage Production Fields

A. Management Strategies (developed by region)

1) Develop strategies and technologies to monitor genetic composition of plant stands.

2) Determine effects of nematodes on legumes in pasture and range situations.

3) Develop efficient diagnostic tools to identify nematodes, viruses, and other pathogens.

4) Document virus and especially luteovirus problems in alfalfa and clovers.

5) Develop good estimates of crop losses due to nematodes and identify nematode species that are causing losses.

6) Develop and evaluate persistent germplasm under grazing conditions.

B. Pest Controls (Genetic, Biocontrol, Natural Products)

Diseases and Nematodes

1) Develop methods and improve or introduce disease resistance to Rhizoctonia, Sclerotinia, Stagnospora, Cercospora, Leptosphaerulina, nematodes, viruses, and root and crown rot complexes.

2) Develop and utilize molecular technologies to identify, isolate, and transfer genes for disease resistance across species.

3) Elucidate specific and general physiochemical mechanisms of genetic and induced resistance.

4) Collect and evaluate native, adapted species of clovers for disease, nematode, and insect resistance.

5) Determine plant response to attack by disease organisms, insects and nematodes.

6) Determine the roles of pathogens and nematodes in alfalfa, red and white clovers, and trefoil stand decline.

Insects

7) Screen, identify, and develop alfalfa germplasm resistant to the potato leafhopper and clover root curculio.

8) Screen, identify, and develop red clover and white clover germplasm resistant to the clover root curculio.

9) Identify natural plant products which provide a defense mechanism against insects attacking alfalfa and which are amenable to gene transfer tecniques.

10) Investigate transfer of genes for glandular hair trait between Medicago species for insect control.

11) Develop and utilize molecular technologies to identify, isolate, and transfer genes for insect resistance.

12) Develop a RFLP system to identify insect resistance.

13) Identify parasites and predators of Lygus species and seed chalcids and study their biology, ecology, and insect-parasite/predator interactions.

14) Investigate the use of pheromones and other factors which disrupt insect behavior in Lygus and seed chalcids.

15) Identify biochemical factors affecting insect resistance.

16) Control insect vectors of virus diseases in forage legumes.

17) Study effects of clover root curculio feeding damage on diseases and persistence in alfalfa, red clover, and white clover.

18) Identify insect pests of native legume species for cropping systems adapted to specific regions of the U.S.

19) Investigate insect-plant interactions of potato leafhopper, alfalfa weevil, and clover root curculio on alfalfa.

20) Develop new and improved non-chemical methods of insect control which would contribute to reduced inputs for sustainable agriculture.

C. Environmental Stress

1) Determine plant response to environmental stress such as temperature extremes, drought, nutrient deficiency , pH and salinity.

2) Identify and develop legume germplasm and cultivars adapted to environmental stress conditions.

3) Develop germplasm with greater winterhardiness and drought tolerance.

4) Investigate the interaction of drought stress and clover root curculio feeding damage.

5) Develop tolerance to pH (Al and Mg) and salinity.

D. Ecological Relationships

1) Determine plant response to grazing, trampling, feces and other stresses imposed by animals in pasture situations.

2) Determine ecology of competition between weeds and forage plants.

3) Identify species combinations for pasture with maximum production and quality throughout the grazing season.

4) Develop legumes for animal grazing.

5) Genetically alter germplasm for tolerance to interspecific competition.

6) Genetically alter germplasm for effective plant-rhizobium symbiosis.

7) Understand interaction of forage legumes and mycorhizae, Rhizobacteria, pathogenic fungi, bacteria, and nematodes.

E. Plant Structure and Function

1) Determine the impact of altered phenolic acid, lignin, and cell wall polysacchride concentrations on the ability of plants to with stand environmental stress, pest resistance, and plant-microbe interactions.

2) Determine the impact of altered protein composition on photosynthesis, plant growth, and persistence.

3) Develop RFLP analysis for use in molecular taxonomy and hybridity identification.

4) Develop DNA fingerprinting for cultivar identification.

5) Development of genetic maps of forage legumes.

6) Develop artificial seed production techniques for use in forage legume hybrid development.

Priority II. -- Improve Quality of Harvested Forage

A. Quality Factors

1) Breed for extension of crop maturity to spread availability of high quality dry matter over time.

2) Breed for leaf retention and more efficient light utilization.

3) Breed for upright leaf orientation.

4) Breed for specific chemical compounds that positively influence forage quality, such as increased ruminal escape protein

5) Breed for decreased stem lignification.

6) Conduct basic studies of phenolic, lignin, cell walls, and polysaccharides to facitilate understanding of genetic mechanisms of control, plant-microbe interactions, and pest resistance.

B. Anti-quality

1) Develop bloat-free alfalfa and other legumes which currently are a danger to animal health/performance.

2) Adjust tannin concentration such that intake is not altered but protein bypass is favored.

3) Breed for low antiquality components - example nitrotoxins.

C. Plant-Animal Interface

1) Breed for improved animal intake

2) Determine which aspects of lignification and cell wall development limit forage digestibility.

3) Deterimine genetic variation for bypass protein so that plants could be developed that allow for greater protein utilization by ruminants.

4) Increase digestion and palatibility of legumes to allow greater animal performance.

5) Identify species mixture for pasture with maximum quality throughout the growing season.

6) Determine how lignification and cell wall development can be slowed so that the decline in forage quality with time is slowed.

E. Pest Management as Related to Quality

1) Determine the effects of plant pathogenic fungi, bacteria, viruses and nematodes on forage quality.

2) Determine the effects of the interaction of diseases and nematodes and plant resistance on forage quality (examples: production of phenols, lignins).

3) Identify and develop nonchemical methods of control for insect pests which affect forage quality.

Priority III. -- Develop New Uses for Forage Legumes

A. Sustainable Agriculture

1) Breed forage legume species for use as cover crops, in intercropping systems, for N2 fixation, and erosion control.

2) Breed forage legumes for low maintenance ground cover.

3) Determine the value of legumes in crop rotations on subsequent or associated crops through nitrogen transfer and other means.

4) Determine mechanism for enhancing the interaction between plant and Rhizobia under different environmental conditions.

5) Develop cropping rotations that allow legumes to provide nitrogen fertilizer requirement of subsequent crops and reduce pests on the next crop.

6) Investigate the effects of clover root curculio feeding damage on nitrogen fixation.

7) Develop legumes to act as trap crops for nematodes.

8) Develop legumes to attract and control insect species such as leafhoppers and aphids which are pests on other major crops.

9) Develop cover crop legumes to harbor and protect beneficial predators and parasites.

10) Develop legumes for use as wildlife cover, protection of water quality, erosion control and soil improvement.

B. Mine Toxic Substances

1) Breed legumes for absorption of toxic substances, e.g. selenium.

2) Breed forage legume for more effecient utilization of nutrients from industrial and agricultural wastes.

Priority IV. -- Develop New Products from Forage Legumes (including seed)

A. Non-food Products

1) Develop new products (uses) from forage legumes - biomass fuel, paper pulp, fertilizer, mulch, birdseed, absorbants, etc.

2) Add novel genes to forage legumes to produce useful chemicals, enzymes, hormones and pharmaceutical products.

B. Food Products

1) Develop new food products that utilize protein and fiber from forage legumes.

2) Identify native legumes that have potential for increased honey production.